Original Article

A Novel Conservative Approach Combining "SealBio" and "Surgical Fenestration" for Healing of Large Periapical Cystic Lesions of Endodontic Origin: A Pilot Study

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Abstract

Objectives: To evaluate the treatment outcome of large periapical cystic lesions treated by combining two novel, conservative approaches, "SealBio" and "Surgical Fenestration". **Materials and Methods:** Five cases (4M:1F, age range 14-38 years, mean age 24.5 years) of large periapical cystic lesions, diagnosed on clinical and radiographic examination, were included in the study. After informed consent, endodontic treatment was initiated; chemo-mechanical preparation and intra-canal dressing of calcium hydroxide was given. At the next sitting after one week, further disinfection root canals was done by "apical clearing", "apical foramen widening" and irrigation. A cotton pellet was kept in the access cavity. After local anaesthesia, full thickness muco-periosteal flap was reflected and the thinned out bone was removed with bone rongers, a small piece of cystic lining was excised and the cystic cavity was copiously flushed with Betadine solution. The remaining cystic lining was gently curetted and the flap was sutured back. "SealBio" was performed after gentle irrigation with saline and intentional over instrumentation. A calcium sulphate based cement was pushed in the cervical third of the canal and the access opening was sealed with glass ionomer cement. Patient was prescribed antibiotics and anti-inflammatory drugs for 5 days and sutures were removed after 7 days. Patients were followed up clinically and radiographically at regular intervals. **Conclusions:** In this pilot study, treatment outcome after combined technique of "SealBio" and "Surgical fenestration" was found to be highly effective in healing of large periapical cystic lesions. It was simple to perform and very conservative treatment; it required minimal bone removal, obviated the need for complete cyst enucleation, apicectomy and retrograde filling.

Keywords: *Minimally invasive periapical surgery, nonobturation endodontic treatment, periapical cyst, regenerative endodontic treatment, SealBio, surgical fenestration*

Introduction

Periapical surgery for the large periapical lesions of endodontic origin is very invasive and is often associated with possible complication of damaging adjoining vital structures. Various conservative approaches have been described in the literature from time to time. Marsupialization and decompression has been used for the management of large cystic lesions.[1] The placement of rubber dam wicks or polyvinyl tubings has been utilized for the purpose, but these have certain disadvantages such as risk of tube dislodgement, entrapment of tissues, recurrent infection, persistence of fistula, multiple visits required, patient compliance, and finally, inability to obtain a biopsy.[1,2]

Natkin *et al.* hypothesized that a surgical procedure involving only rupture of the cyst sac and partial removal of the tissue from the lesion would establish short-term drainage induce surgical trauma leading to acute inflammation, followed by reparative response and complete resolution of the lesion.[3] This hypothesis was based on the observation made by Oehlers that a large pathology heals spontaneously, once the offending tooth/teeth are extracted.[4] Wong[5] first published two case reports based on this hypothesis and termed the technique as "surgical fenestration." The author in 1998 compared surgical fenestration with conventional surgical and nonsurgical treatment for large periapical lesion.[6] It reported that the quality of postoperative healing after surgical fenestration was comparable to conventional endodontic surgery and also the initial healing rate was faster. Moreover, surgical fenestration was judged to be simple and easy to perform,

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least traumatic with minimal postoperative complications. It had an additional advantage that it provided tissue sample for biopsy of the lesion, especially in cases where there was a diagnostic dilemma regarding its origin, whether of endodontic or nonendodontic origin. Thus, it was concluded to be a minimally invasive surgical alternative for the management of large, cyst-like periapical lesions.[7]

"SealBio" is a novel, regeneration-based, nonobturation endodontic treatment for the management of pulp and periapically involved mature permanent teeth. It was first reported in 2012, and successful outcome was documented in 14 cases.[8] The technique incorporates "apical clearing"[9,10] and "apical foramen widening"[11] to achieve more effective disinfection. It is then followed by intentional overinstrumentation into the periapical region to induce bleeding near the apical foramen and to provide a scaffold of a blood clot. It is hypothesized that the endogenous, locally residing stem cells will populate the scaffold, differentiate into forming cells, and lay down fibrous/cemental tissue to achieve a biological seal over the apical foramen, hence the term "SealBio". A suitable coronal seal is provided to prevent coronal microleakage and reinfection in future. The technique has been patented. (Australian patent no. 20103555089 dated January 9, 2014, and US patent no. 9,180,072 B2 dated November 10, 2015). Recently, 6-year experience with SealBio was reported, which documents that the technique is effective in cases of large periapical lesions and is compatible for post and core restoration after endodontic treatment unlike regenerative procedures in immature teeth.[12]

Since both the techniques, i.e., surgical fenestration and SealBio have been individually shown to be effective, it was hypothesized that both together will also be successful in the management of large periapical cystic lesions of endodontic origin. Therefore, a pilot study was planned to test this hypothesis, and five patients were recruited, treated by this combination treatment after getting their informed consent.

This article presents five cases of large, cyst-like periapical lesions, successfully treated. The procedure performed and the protocol followed for all the cases were the same and therefore explained in detail only for the first case, while case histories of the remaining cases are presented.

Case Reports

Case 1

A 38-year-old man reported with the complaint of swelling and continuous dull pain in the maxillary right anterior region. He gave the history of trauma 5 years back. Clinical examination revealed a diffuse swelling in labial vestibule above the maxillary right canine, extending from distal of the right maxillary central incisor till the mesial aspect of the second premolar. On palpation, the bony expansion with eggshell crackling was felt at one or two places. Maxillary right canine was tender to percussion, was grade II mobile, and did not respond to vitality test, both by cold and electric pulp sensitivity tests. Radiographic evaluation by intraoral periapical X-ray revealed a well-corticated radiolucency of 15 mm × 12 mm in size, associated with the maxillary right canine. Provisional diagnosis of infected radicular cyst was made. Combination of "surgical fenestration" and "SealBio" was planned for the case. The patient was explained the treatment procedures to be performed, to which he agreed readily and signed the informed consent form. Root canal access opening was done under rubber dam. Working length was taken with electronic apex locator and reconfirmed with the help of X-ray. Chemomechanical preparation was done up to ISO size #80 K-file under copious irrigation with 1% sodium hypochlorite. The root canal was then dried with sterile paper points, and calcium hydroxide paste was given as the intracanal medicament. The surgery was planned after 1 week. On the appointment day, after the removal of $Ca(OH)_2$ dressing, "apical clearing" was done, which involved enlarging the apical third 2–4 sizes larger than the master apical file (MAF) by dry reaming, to remove loose debris from the apical end. In this case, the apical enlargement was done to size #100 file (2 sizes larger than MAF of #80), maintaining the apical patency. The canal was flushed with copious irrigation with Betadine solution. "Apical foramen widening" was then done with increasing number of K-files from size #10 till size #25–30, the canal was flushed again, and a cotton pallet was placed in the access opening.

The case was prepared for surgery by extraoral scrub and intraoral Betadine application and mouth rinse. The right infraorbital block was given along with incisive canal nerve block with 2% lignocaine hydrochloride. A crevicular incision, with two vertical releasing incisions, was given and full-thickness mucoperiosteal labial flap was reflected from right lateral incisor to first premolar. The shell-like bone over the canine region was removed with bone rongeurs, and a small piece of lining epithelium was excised with the blade. The cystic cavity was irrigated with 20 ml of Betadine solution and aspirated with suction. With a surgical curette, the entire cystic lining was gently curetted and the flap was sutured with 3.0 silk sutures.

After closure of the surgical site, the cotton pallet from the access cavity was removed and the canal was flushed with normal saline and dried with paper points. The endodontic procedure "SealBio" was then performed as follows: with a no. #20 K-file, overinstrumentation was done for 2–3 mm into the periapical area and calcium sulfate-based cement (Cavit, 3M ESPE, USA) was then gently pushed in the cervical third of the canal with root canal plugger. Excess cement from the access cavity was removed, and the cavity walls were conditioned with polyacrylic acid and sealed with glass-ionomer cement. The patient was given

a course of antibiotics and anti-inflammatory medication for 5 days. Postoperative period was uneventful. The patient was recalled on the 7th day, and the sutures were removed. At the follow up appointment at 4 months, the patient was asymptomatic and X-rays showed evidence of healing, with bone filling in from periphery toward the center. Histopathology of the specimen reported chronic inflammatory granulation tissue [Figure 1].

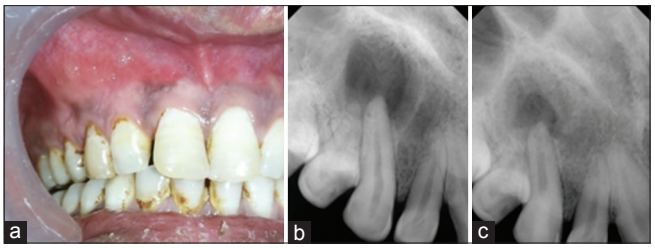

Figure 1: Case 1 38/M: (a) Clinical photograph showing extensive bone expansion over tooth #13. (b) Intraoral radiograph showing well-circumscribed radiolucency involving the right canine. (c) Four months after surgical fenestration and SealBio, excellent healing is evident.

Case 2

An 18-year-old boy presented with the complaint of pain and swelling in his upper front teeth for the past 1 week. He gave the history of recurrent episodes of pain and swelling over the past 2 years, which partially resolved after medication prescribed by private practitioner. He had undergone root canal treatment in #11 5 years ago. On examination, he had diffuse swelling in the labial vestibule, which was tender on palpation. Intraoral X-ray showed a periapical lesion 2 cm × 1 cm with clear margins. It was planned to retreat tooth #11 and perform SealBio and surgical fenestration [Figure 2].

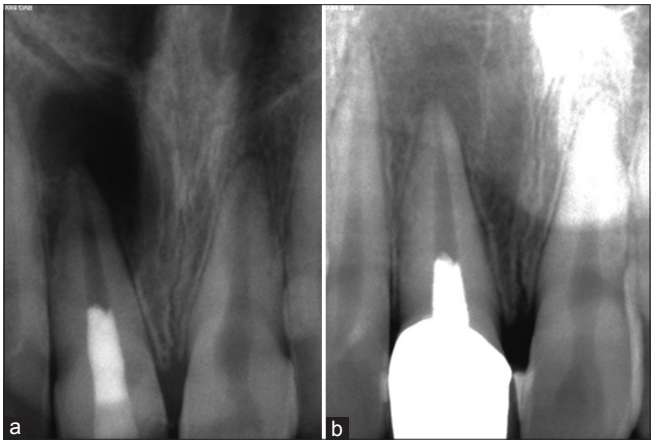

Figure 2: Case 2 18/M: (a) Immediate posttreatment radiograph showing a large cystic lesion associated with tooth #11. (b) Follow-up radiograph at 5 months showing remarkable decrease in the size of the lesion

Case 3

A 14-year-old girl presented with a large balloon-shaped swelling in relation to her lower anterior teeth. She gave the history of swelling being present for the past 8 months, which gradually increased to the present size. On examination, there was diffuse buccal bone expansion on the labial side from right canine to left canine region and also mild expansion of the lingual plate. On palpation, fluctuation was felt on the labial side in the lower #11 region. There was grade 2 + mobility of teeth #31 and 41. On intraoral periapical X-ray, a large well-defined radiolucent lesion was seen measuring 5 cm × 3 cm and pushing the roots of both the affected teeth apart. On vitality testing, all the four incisors were nonvital. On aspiration, oily straw-colored fluid could be aspirated. With a provisional diagnosis of large radicular cyst, surgical treatment with SealBio was planned, and the patient was informed regarding both the conservative approaches, to which the patient's parents readily agreed. On surgical opening, the roots of #31 and 41 were found to be completely denuded of its bony cover and were excessively mobile. After the surgical procedure, a fiber splint was given extending from the right to left canine for 3 weeks. The excised tissue was sent for histopathology, which reported it as inflammatory granulation tissue with spicules of bone and fibrosis [Figure 3].

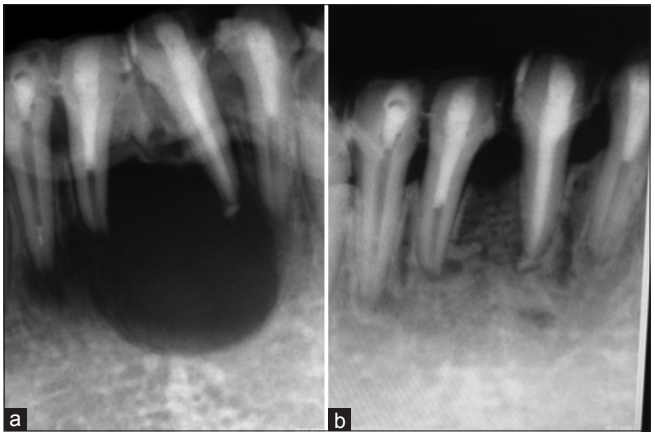

Figure 3: Case 3 14/F: (a) Intraoral radiograph showing a large cystic lesion involving all mandibular incisors; the roots of teeth #41 and 31 are pushed apart. (b) At 8-month follow-up after surgical fenestration, SealBio, and splinting for 3 weeks, excellent healing response is seen

Case 4

A 35-year-old man reported with a very well-defined swelling on the palatal aspect of upper incisors. The swelling was just behind the incisive papilla and was firm in consistency. The overlying mucosa was pale pink showing no inflammatory changes. There was swelling in the labial vestibule associated with teeth #11 and 12. The patient gave the history of swelling being present for the past 1 year. On vitality testing, teeth #21, 11, and 12 were negative. The patient was advised panoramic, occlusal, and intraoral X-rays. The X-ray finding was interesting; there was a large cystic shadow measuring 10 cm × 5 cm with a small mesiodens over the root apex of #11. Since the teeth were found to be nonvital, the provisional diagnosis was kept as radicular cyst, and a possibility of dentigerous cyst involving the mesiodens was kept in differential diagnosis.

It was planned to perform endodontic treatment of #21, 11, and 12 and perform surgical fenestration for two reasons; as a curative treatment for radicular cyst and to establish a diagnosis if in case, it was a dentigerous cyst. The patient was explained treatment modality of both the procedures with its benefits and the risk of undergoing a second surgical procedure if it was a dentigerous cyst for complete enucleation. The patient agreed for the treatment. On opening the flap and exposing the cystic cavity, interestingly, the mesiodens was found to be lying loose on the palatal aspect in the cystic cavity, far from the apex of tooth #11. The tooth was gently picked up with tweezers, and the cavity was irrigated and treated as described earlier. The histopathological report was radicular cyst [Figure 4].

Case 5

A 14-year-old boy presented with a large swelling on palatal aspect of #21. He gave the history of trauma at the age of 9 years. On examination, tooth #21 was discolored. On vitality testing, #21 was negative and #11 and 22 were vital. On intraoral periapical radiograph, a very well-defined radiolucency, measuring 3 cm × 4 cm, was seen. Keeping in view the discolored nonvital tooth, palatal swelling, and radiographic feature of a cystic lesion, a provisional diagnosis of radicular cyst was made. It was decided to perform surgical endodontics. Patient's consent was taken for both the procedures; surgical fenestration and SealBio. The histopathology report was radicular cyst [Figure 5].

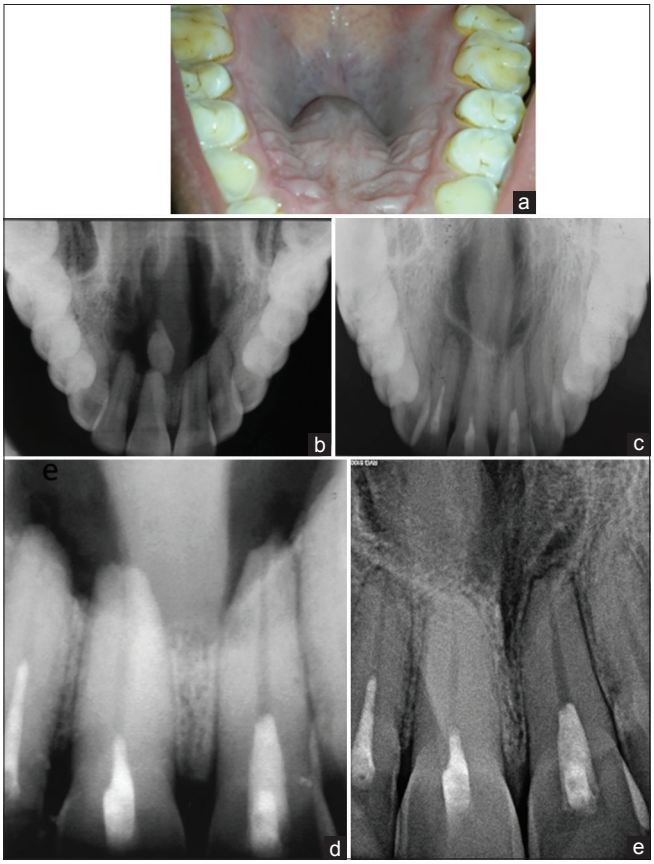

Figure 4: Case 4 38/M: (a) Clinical photograph showing a well-demarcated, firm swelling on anterior palate in the midline. (b) Occlusal radiograph showing a large cystic lesion with a mesiodens, appearing like a dentigerous cyst. However, his tooth #11 was discolored and on vitality testing, #11, 21, and 22 were nonvital. Extraction of mesiodense, Surgical fenestration and SealBio was performed. (c) At 8-month follow-up, the patient was symptom-free and palatal swelling had subsided. On radiograph, the radiolucent lesion showed decrease in the size of the lesion. (d and e) The decrease in lesion size can be better appreciated in the cropped up image of occlusal radiographs immediately after surgery and at 15 months. Note the complete lamina dura regeneration around #11 and 21 in the follow-up X-ray

Discussion

The success of endodontic treatment depends on the removal of all necrotic debris and thorough disinfection of the root canal system, to create environment conducive for healing of periapical tissues.[13] When the source, i. e., the infection within the root canal system is removed, the periapical lesion begins to heal. However, successful management of large cyst-like periapical lesion by orthograde root canal treatment alone may not be successful and sometimes may not be desirable, where biopsy of the lesion is required to establish the diagnosis.

Periapical cystic lesion develops by host-mediated defense against continuous insult by microorganism and its by-products from the root canal system. This chronic process leads to activation and continuous cell division of the epithelial cell rests of Malassez and osteoclast-induced bone resorption, leading to the development of a periapical cyst.[14] It has been shown that as the lesion size increases, accuracy of cyst identification increases.[6,15] However, the definite diagnosis can only be established by correlation of clinical signs and symptoms and radiographic features with histopathological examination. The diagnosis of a periapical cyst can be made only when a lesion has been examined with serial sectioning of the specimen; random sectioning may miss the diagnosis of a cyst.[16]

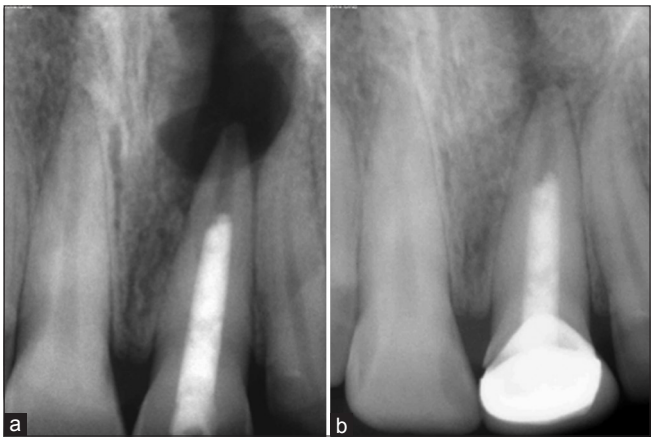

Figure 5: Case 5 14/M: (a) Immediate posttreatment (surgical fenestration and SealBio) radiograph showing a large, well-defined cystic radiolucency associated with tooth #21. (b) Follow-up at 1 year showing complete resolution of the apical lesion

Different treatment modalities to manage periapical pathologies by orthograde non-surgical endodontic treatment (NSET) has been advocated in the past, such as: (a) intentional overinstrumentation beyond the root apex or (b) packing of calcium hydroxide in root canals.[17,18] It was believed that overinstrumentation leads to decompression of lesion, induces acute inflammatory response, and leads to initiation of healing response. Similar effect is expected with calcium hydroxide; due to its high alkalinity, calcium hydroxide can cause irritation and inflammatory response in the periapical area and thus can initiate healing response.

Other approach suggested is decompression and to provide drainage of cystic fluid, to first reduce the size of the lesion, and subsequently enucleate the entire lesion.[19] The advantage of this method is that it would reduce the chances of damaging the adjacent vital structures and would not compromise the vitality of adjacent teeth. However, decompression has many disadvantages as follows:[20] (a) longer treatment time requiring multiple visits, (b) local infection and frequent inflammation, (c) tube may get submerged into the lesion, and (d) biopsy of the lesion is not possible.

Surgical fenestration is a simple, minimally invasive surgical technique, which does not require complete enucleation of cystic lining. In most large lesions, there is usually bone erosion and a window in the bony cortex may exist. If required, the opening can be enlarged, by removing the shell-like bone, and a small piece of cystic lining is taken for histopathological evaluation. The cystic cavity is irrigated with large volume of Betadine solution and aspirated. Finally, the remaining cystic lining is gently curetted to induce mild ulceration and the flap is sutured back.

Advantages of surgical fenestration over conventional surgery are as follows: it provides adequate drainage, prevents excessive cutting and removal of bone that is required to expose the entire lesion as would be required for complete enucleation, less time-consuming, and easy to perform. Moreover, it provides flexibility of performing other procedures such as apicoectomy and retrograde filling and removal of mesiodens, if required. It allows to take tissue specimen for histopathological evaluation unlike in other decompression methods previously described. It prevents chances of trauma to adjacent vital structures and conserves bone, as the entire lesion needs not to be exposed. The removal of lesser quantity of the bone also leads to faster and better healing response, as healing response was seen as early as at 6 weeks after surgery.

Traditionally, before doing any endodontic surgical procedure, it is required to disinfect and obturate the entire canal system. Gutta-percha with sealer cement is the most commonly used root canal obturation. However, more recently, regeneration-based endodontic procedures are being discussed. The ultimate aim is to achieve a cemental/fibrous barrier at the root apex. The novel, regeneration-based, nonobturation technique "SealBio" was developed and reported in 2012, in which 18 fully mature, infected teeth were successfully treated by this technique.[8] In this technique, root canals are not obturated; instead, attempt is made to induce a biological seal of fibrous or cementum tissue at the root apex (as occurs even after conventional root canal treatment with obturation), which is the most desirable outcome after endodontic treatment.[21]

It was generally believed that it is impossible to eliminate all microorganisms from the root canal space, and hence, the residual microorganisms should be entombed by three-dimensional obturation. However, now, it is understood that a critical mass of microbial population (10^3–10^4) is required to sustain or cause periapical infection/reinfection.[22] "Apical clearing" and "apical foramina widening" can achieve this level of reduction in microbial load. "Apical clearing" is the widening of the apical third of the canal 2-4 sizes larger than the MAF by dry reaming. This helps to remove all accessory canals, bifurcations, deltas, etc., present in the apical third.[9,10] "Apical foramen widening" to size #25 helps to clean the cemental part of the canal,[11] which is generally nacrosed and harbors large quantity of microbes. The root canal is then irrigated with copious volume of 2.5% NaOCl and final flush with Betadine solution. The canal is dried with paper points, and with a sterile #20 K-file, overinstrumentation to 2–3 mm into the periapical region is done to induce bleeding close to the apical foramen. The clot formed would provide a scaffold into which all the locally residing endogenous stem cells (bone marrow mesenchymal stem cells, stem cells from the apical papilla, periodontal ligament stem cells, etc.)[23] can get implanted, grow, differentiate into various forming cells such as fibroblast, cementoblast, and osteoblasts, and form a mineralized barrier of biological tissues, sealing the apical foramen; hence the term "SealBio".

It was hypothesized that the regeneration-based protocol "SealBio" and "surgical fenestration" combined together would be effective for the treatment of large cystic lesions requiring surgical endodontic treatment. As the cystic fluid, extravasated blood, and other debris from the lesion are cleansed by "surgical fenestration" and augmented root canal disinfection is achieved by "apical clearing" and "apical foramen widening" in "SealBio" proved the hypothesis correct, as excellent healing of large periapical cystic lesions, even at short follow-up periods (in some cases, as early as 6–12 weeks), without any adverse clinical signs and symptoms was seen in all the five cases.

Conclusion

Combining the two novel, conservative techniques of surgical fenestration and SealBio to treat large

periapical cystic lesions was found to be very effective, both on clinical and radiographic evaluation. This ultra-conservative approach documents the advantages of minimum surgical trauma and rapid healing as minimal bone removal needs to be done. It also has the advantage of being very cost-effective in terms of minimal complications, postoperative sequel, and simpler to perform with good treatment outcome. The study needs to be followed up by a well-planned case-controlled study with larger sample size.

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Conflicts of interest

There are no conflicts of interest.

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